

DAFTAR PUSTAKA

- Abd-El-khalick, F., & Lederman, N. G. (2000). Improving science teachers' conceptions of nature of science: A critical review of the literature. *International Journal of Science Education*, 22(7), 665–701. <https://doi.org/10.1080/09500690050044044>
- Abdurrahman, A., Maulina, H., Nurulsari, N., Sukamto, I., Umam, A. N., & Mulyana, K. M. (2023). Impacts of integrating engineering design process into STEM makerspace on renewable energy unit to foster students' system thinking skills. *Heliyon*, 9(4), e15100. <https://doi.org/10.1016/j.heliyon.2023.e15100>
- Adams, P. (2012). Exploring social constructivism: Theories and practicalities. In *Oxford University Press*. Oxford University Press. <https://doi.org/10.1080/03004270600898893>
- AERA, A. E. R. A. (2014). Standards for educational and psychological testing. In *National Council on Measurement in Education*.
- Agnes, Y., Turnip, A., Mungkin, M., Maizana, D., & Satria, H. (2024). Rancang Bangun Baterai Alternatif Menggunakan Metode Sel Volta dengan Charger Panel Surya Design. *Electron: Jurnal Ilmiah Teknik Elektro*, 5(November).
- Aini, S. N., Munahefi, D. N., Pramasdyahsari, A. S., & Setyowati, R. D. (2024). Engineering Design Process STEM: Proyek Miniatur Gazebo Joglo. *PRISMA, Prosiding Seminar Nasional Matematika*, 7, 37–43. <https://proceeding.unnes.ac.id/prisma>
- Akpan, B., & Kennedy, T. J. (2020). Science Education in Theory and Practice. *Springer Texts in Education*. <https://doi.org/10.1007/978-3-030-43620-9>
- Amanda, F. D., Dewi, U. P., Mufit, F., & Festiyed, F. (2023). Influence of Essay Assessment on Student Competency Achievement in Science Learning: Literature Review. *Jurnal Penelitian Pendidikan IPA*, 9(9), 539–549. <https://doi.org/10.29303/jppipa.v9i9.4994>
- Arends, R. I. (2012). Learning to teach. In *McGraw-Hill* (9th ed.). McGraw-Hill.
- Arikunto, S. (2009). Dasar-dasar Evaluasi Pendidikan. In *Bumi Aksara*.
- Astuti, I. A., Suhandi, A., Sopandi, W., Sujana, A., & Nurnaningrum, G. (2025). Analysis of Elementary School Students' Science Process Skills in the Merdeka Curriculum. *Jurnal Penelitian Pendidikan IPA*, 11(2), 837–844. <https://doi.org/10.29303/jppipa.v11i2.10147>
- Asunda, P. A., & Hill, R. B. (2017). Critical Features of Engineering Design in Technology Education. *Journal of Industrial Teacher Education*, 44(1), 25–48.
- Athuman, J. J. (2017). Comparing the effectiveness of an inquiry-based approach to that of conventional style of teaching in the development of students' science process skills. *International Journal of Environmental & Science Education*, 12(8), 1797–1816.
- Atman, C. J., Adams, R. S., Cardella, M. E., Turns, J., Mosborg, S., & Saleem, J. (2007). Engineering design processes: A comparison of students and expert practitioners. *Journal of Engineering Education*, 96(4), 359–379.

<https://doi.org/10.1002/j.2168-9830.2007.tb00945.x>

- Atwater, M. M. (1996). Social Constructivism: Infusion into the Multicultural Science Education Research Agenda. *Journal of Research in Science Teaching*, 33(8), 821–837. [https://doi.org/10.1002/\(SICI\)1098-2736\(199610\)33:8<821::AID-TEA1>3.0.CO;2-Y](https://doi.org/10.1002/(SICI)1098-2736(199610)33:8<821::AID-TEA1>3.0.CO;2-Y)
- Ausubel, D. P. (1968). Educational Psychology: A Cognitive View. In *Holt, Rinehart and Winston Inc.* <https://doi.org/10.2307/1161899>
- Ausubel, D. P., Novak, J. D., & Hanesian, H. (1982). *Psicología educativa: un punto de vista cognoscitivo. [Educational psychology: a cognitive point of view]*. Trillas.
- Avsec, S. (2023). Design Thinking to Envision More Sustainable Technology-Enhanced Teaching for Effective Knowledge Transfer. *Sustainability (Switzerland)*, 15(2). <https://doi.org/10.3390/su15021163>
- B. N. Bruke. (2014). 6E learning byDeSIGNTM model. *Technol. Eng. Teach.*, 73(6), 14–19.
- Bada, & Olusegun, S. (2015). The psychogenesis of Knowledge and its Epistemological Significance. *Journal of Research and Method in Education*, 5(6), 23–34. <https://doi.org/10.9790/7388-05616670>
- Badwan, B., Bothara, R., Latijnhouwers, M., Smithies, A., & Sandars, J. (2018). The importance of design thinking in medical education. *Medical Teacher*, 40(4), 425–426. <https://doi.org/10.1080/0142159X.2017.1399203>
- Bahtiar, B., & Dukomalamo, N. (2019). Basic science process skills of biology laboratory practice: improving through discovery learning. *Biosfer*, 12(1), 83–93. <https://doi.org/10.21009/biosferjpb.v12n1.83-93>
- Bandura, Albert. (1999). Social Cognitive Theory: An Agentic Perspective. *Asian Journal of Social Psychology*, 2(1), 1–26.
- Banilower, E. R., Smith, S. P., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). Report of the 2012 National Survey of Science and Mathematics Education February 2013 Horizon Research, Inc. *Horizon Research Inc.* <https://eric.ed.gov/?id=ED541798>
- Barak, M. (2017). Science Teacher Education in the Twenty-First Century: a Pedagogical Framework for Technology-Integrated Social Constructivism. *Research in Science Education*, 47(2), 283–303. <https://doi.org/10.1007/s11165-015-9501-y>
- Beghetto, R. A., & Karwowski, M. (2017). Toward Untangling Creative Self-Beliefs. In *The Creative Self: Effect of Beliefs, Self-Efficacy, Mindset, and Identity*. Elsevier Inc. <https://doi.org/10.1016/B978-0-12-809790-8.00001-7>
- Bell, R. L., Maeng, J. L., & Binns, I. C. (2013). Learning in context: Technology integration in a teacher preparation program informed by situated learning theory. *Journal of Research in Science Teaching*, 50(3), 348–379. <https://doi.org/10.1002/tea.21075>
- Benavides, E. (2012). *Advanced engineering design: an integrated approach*. Woodhead Publishing.
- Biesta, G. J. J., & Burbules, N. C. (2003). Pragmatism and educational research. In *Rowman & Littlefield Publishers*.
- Blizzard, J., Klotz, L., Potvin, G., Hazari, Z., Cribbs, J., & Godwin, A. (2015).

- Using survey questions to identify and learn more about those who exhibit design thinking traits. *Design Studies*, 38, 92–110. <https://doi.org/10.1016/j.destud.2015.02.002>
- Brenner, W., & Uebernickel, F. (2016). Design thinking for innovation: Research and practice. *Design Thinking for Innovation: Research and Practice, February 2016*, 1–219. <https://doi.org/10.1007/978-3-319-26100-3>
- Brookhart, S. M., & Nitko, A. J. (2014). Educational assessment of students. In *Pearson*.
- Brown, M. B., & Forsythe, A. B. (1974). Robust tests for the equality of variances. *Journal of the American Statistical Association*, 69(346), 364–367. <https://doi.org/10.1080/01621459.1974.10482955>
- Bruner, J. S. (1960). The process of education. In *Harvard University Press*. <https://doi.org/10.4159/9780674028999-006>
- Bruner, J. S. (1961). the Act of Discovery. In *Harv Educ Rev* (pp. 21–32). <https://doi.org/10.4324/9780203088609-13>
- Bruner, J. S. (1966). *Toward a Theory of Instruction*. Belkapp.
- Bruner, J. S. (1997). A Narrative Model of Self-Construction. *Annals New York Academy of Sciences*.
- Bryman, A. (2012). Social Research Methods. In *Oxford University Press Inc. SAGE Publications*.
- Burghardt, M. D., & Hacker, M. (2004). Informed Design: A Contemporary Approach to Design Pedagogy. *The Technology Teacher*.
- Burghardt, M. D., & Hacker, M. (2014). Informed Design: A Contemporary Approach to Design Pedagogy. *International Technology Education Association*.
- Caine, R. N., & Caine, G. (1994). *Making connections : teaching and the human brain*. <http://ezproxy.lib.ed.ac.uk/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=cat00234a&AN=edinb.1649799&site=eds-live>
- Camacho, M. (2018). An Integrative Model of Design Thinking An Integrative Model of Design Thinking by. *The 21st DMI: Academic Design Management Conference, August*.
- Campbell, D. T., & Stanley, J. C. (1963). Experimental and Quasi-Experimental Designs for Research. In *Wadsworth Publishing*.
- Capobianco, B. M. (2011). Exploring a Science Teacher's Uncertainty with Integrating Engineering Design: An Action Research Study. *Journal of Science Teacher Education*, 22(7), 645–660. <https://doi.org/10.1007/s10972-010-9203-2>
- Capraro, R. M., Capraro, M. M., & Morgan, J. R. (2013). STEM Project-Based Learning: An Integrated Science, Technology, Engineering, and Mathematics (STEM) Approach, Second Edition. In *Sense Publishers*. <https://doi.org/10.1007/978-94-6209-143-6>
- Carlgren, L., Rauth, I., & Elmquist, M. (2016). Framing Design Thinking: The Concept in Idea and Enactment. *Creativity and Innovation Management*, 25(1), 38–57. <https://doi.org/10.1111/caim.12153>
- Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M.

- (2010). Destination, Imagination and the Fires within: Design Thinking in a Middle School Classroom. *International Journal of Art & Design Education*, 29(1), 37–53.
- Chang, R. (2010). Chemistry. In *McGraw-Hill*. McGraw-Hill. [https://doi.org/10.1016/0149-1970\(80\)90015-3](https://doi.org/10.1016/0149-1970(80)90015-3)
- Chao, J., Xie, C., Nourian, S., Chen, G., Bailey, S., Goldstein, M. H., Purzer, S., Adams, R. S., & Tutwiler, M. S. (2017). Bridging the design-science gap with tools: Science learning and design behaviors in a simulated environment for engineering design. *Journal of Research in Science Teaching*, 54(8), 1049–1096. <https://doi.org/10.1002/tea.21398>
- Charlesworth, R. (2016). Math and Science for Young Children, Eighth Edition. In *Cengage Learning*.
- Chin, C., & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education*, 44(1), 1–39. <https://doi.org/10.1080/03057260701828101>
- Choirunnisa, N. L., Prabowo, P., & Suryanti, S. (2018). Improving Science Process Skills for Primary School Students Through 5E Instructional Model-Based Learning. *Journal of Physics: Conference Series*, 947(1). <https://doi.org/10.1088/1742-6596/947/1/012021>
- Claus D., J. (2016). “Making Is Thinking”: The Design Practice of Crafting Strategy. *Design Thinking for Innovation*, November, 1–219. <https://doi.org/10.1007/978-3-319-26100-3>
- Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education. In *Routledge*.
- Cook, K. L., & Bush, S. B. (2018). Design thinking in integrated STEAM learning: Surveying the landscape and exploring exemplars in elementary grades. *School Science and Mathematics*, 118(3–4), 93–103. <https://doi.org/10.1111/ssm.12268>
- Cooper, D. R., & Schinder, P. . (2006). Business research methods: Empirical investigation. In *Journal of service research* (Vol. 1, Issue 2).
- Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches*. SAGE Publications.
- Creswell, J. W., & Guetterman, T. C. (2019). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research. In *Pearson*.
- Crismond, D. P., & Adams, R. S. (2012). The informed design teaching and learning matrix. *Journal of Engineering Education*, 101(4), 738–797. <https://doi.org/10.1002/j.2168-9830.2012.tb01127.x>
- Cullen, D. M., & Pentecost, T. C. (2011). A model approach to the electrochemical cell: An inquiry activity. *Journal of Chemical Education*, 88(11), 1562–1564. <https://doi.org/10.1021/ed101146u>
- Dahar, R. W. (2021). *Teori-teori Belajar & Pembelajaran*. Penerbit Erlangga.
- Darmaji, D., Kurniawan, D. A., Astalini, A., & Setiya Rini, E. F. (2022). Science Processing Skill and Critical Thinking: Reviewed Based on the Gender. *JPI (Jurnal Pendidikan Indonesia)*, 11(1), 133–141. <https://doi.org/10.23887/jpi-undiksha.v11i1.35116>

- DeVellis, R., & Thorpe, C. (2022). *Scale Development Fifth Edition*. In *SAGE Publications*.
- Dewey, J. (1910). *How we think*. In *D.C. Heath & Co.*
_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI
- Dewey, J. (1929a). *Experience and nature*. *George Allen and Unwin LTD*.
_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI
- Dewey, J. (1929b). *The Quest For Certainty: A Study of The Relation of Knowledge and Action*. In *Gifford Lectures*.
- Dewey, J. (1933). *How we think: A restatement of relation of reflective thinking and education process*. *D.C. Heath and Co. Publishers*, 1–242.
- Dewey, J. (1938). *John Dewey: Experience and Education*. In *Americas New York, NY 1002*.
- Diana, N., Yohannes, & Sukma, Y. (2021). The effectiveness of implementing project-based learning (PjBL) model in STEM education: A literature review. *Journal of Physics: Conference Series*, 1882(1).
<https://doi.org/10.1088/1742-6596/1882/1/012146>
- Dixon, R. A., & Brown, R. A. (2012). Transfer of learning: Connecting concepts during problem solving. *Journal of Technology Education*, 24(1), 2–17.
<https://doi.org/10.21061/jte.v24i1.a.1>
- Dolata, M., & Schwabe, G. (2016). Design Thinking in IS Research Projects. *Design Thinking for Innovation*. <https://doi.org/10.1007/978-3-319-26100-3>
- Dorst, K. (2011). The core of “design thinking” and its application. *Design Studies*, 32(6), 521–532. <https://doi.org/10.1016/j.destud.2011.07.006>
- Dosi, C., Rosati, F., & Vignoli, M. (2018). Measuring design thinking mindset. *Proceedings of International Design Conference, DESIGN*, 5, 1991–2002.
<https://doi.org/10.21278/idc.2018.0493>
- Drake, S. M. (2012). *Creating Standars-Based Integrated Curriculum*. Corwin.
- Driscoll, M. P. (2014). *Psychology of Learning Instruction*. Pearson.
- Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, 12(1), 1207–1222. <https://doi.org/10.29333/iji.2019.12177a>
- Durmaz, H., & Mutlu, S. (2017). The effect of an instructional intervention on elementary students’ science process skills. *Journal of Educational Research*, 110(4), 433–445. <https://doi.org/10.1080/00220671.2015.1118003>
- Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., & Leifer, L. J. (2006). Engineering design thinking, teaching, and learning. *IEEE Engineering Management Review*, 34(1), 65–90.
<https://doi.org/10.1109/emr.2006.1679078>
- Dym, C. L., Little, P., & Orwin, E. J. (2002). Engineering design: a project-based introduction. In *Materials & Design* (Vol. 23, Issue 1).
[https://doi.org/10.1016/s0261-3069\(01\)00050-4](https://doi.org/10.1016/s0261-3069(01)00050-4)
- Edutopia. (2016). *Multiple Intelligences: What Does the Research Say?* George Lucas Educational Foundation. <https://www.edutopia.org/multiple-intelligences-research>
- Eggen, P. O., & Skaugrud, B. (2015). *An Easy-To-Assemble Three-Part Galvanic*

- Cell. *Journal of Chemical Education*, 92(6), 1053–1055. <https://doi.org/10.1021/ed500726y>
- Eisenhart, M., Finkel, E., & Marion, S. F. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, 33(2), 261–295. <https://doi.org/10.3102/00028312033002261>
- Ejiwale, J. A. (2013). Barriers to successful implementation of STEM education. *Journal of Education and Learning*, 7(2), 63–74. https://doi.org/10.1007/978-3-319-24436-5_20
- Ekici, M., & Erdem, M. (2020). Developing Science Process Skills through Mobile Scientific Inquiry. *Thinking Skills and Creativity*, 36(April), 100658. <https://doi.org/10.1016/j.tsc.2020.100658>
- Elfeky, A. I. M., Masadeh, T. S. Y., & Elbyaly, M. Y. H. (2020). Advance organizers in flipped classroom via e-learning management system and the promotion of integrated science process skills. *Thinking Skills and Creativity*, 35, 100622. <https://doi.org/10.1016/j.tsc.2019.100622>
- Elsbach, K. D., & Stigliani, I. (2018). Design Thinking and Organizational Culture: A Review and Framework for Future Research. *Journal of Management*, 44(6), 2274–2306. <https://doi.org/10.1177/0149206317744252>
- English, L. D., & King, D. (2019). STEM Integration in Sixth Grade: Desligning and Constructing Paper Bridges. *International Journal of Science and Mathematics Education*, 17(5), 863–884. <https://doi.org/10.1007/s10763-018-9912-0>
- English, L. D., & King, D. T. (2015). STEM learning through engineering design: fourth-grade students' investigations in aerospace. *International Journal of STEM Education*, 2(1). <https://doi.org/10.1186/s40594-015-0027-7>
- Ergazaki, M., Saltapida, K., & Zogza, V. (2010). From Young Children's Ideas about Germs to Ideas Shaping a Learning Environment. *Research in Science Education*, 40(5), 699–715. <https://doi.org/10.1007/s11165-009-9140-2>
- Ergazaki, M., Zogza, V., & Grekou, A. (2009). From preschoolers' ideas about decomposition, domestic garbage fate and recycling to the objectives of a constructivist learning environment in this context. *Review of Science, Mathematics and ICT Education*, 3(1), 99–121.
- Ero-Tolliver, I., Lucas, D., & Schauble, L. (2013). Young Children's Thinking About Decomposition: Early Modeling Entrees to Complex Ideas in Science. *Research in Science Education*, 43(5), 2137–2152. <https://doi.org/10.1007/s11165-012-9348-4>
- Fan, S. C., & Yu, K. C. (2016). Core value and implementation of the science, technology, engineering, and mathematics curriculum in technology education. *Journal of Research in Education Sciences*, 61(2), 183–2016. [https://doi.org/10.6209/JORIES.2016.61\(2\).06](https://doi.org/10.6209/JORIES.2016.61(2).06)
- Fan, S. C., Yu, K. C., & Lin, K. Y. (2020). A Framework for Implementing an Engineering-Focused STEM Curriculum. In *International Journal of Science and Mathematics Education* (Vol. 19, Issue 8). International Journal of Science and Mathematics Education. <https://doi.org/10.1007/s10763-020-10129-y>
- Fan, S. C., Yu, K. C., & Lou, S. J. (2017). Why do students present different

- design objectives in engineering design projects? *International Journal of Technology and Design Education*, 28(4), 1039–1060.
<https://doi.org/10.1007/s10798-017-9420-5>
- Ferguson, R., Coughlan, T., Egelanddsdal, K., & Gaved, M. (2019). *Innovating Pedagogy 2019: Open University Innovation Report 7* (Issue January). Milton Keynes: The Open University.
<https://doi.org/10.13140/RG.2.2.16773.40161>
- Ferrés-Gurt, C. (2017). El reto de plantear preguntas científicas investigables. *Revista Eureka Sobre Enseñanza y Divulgación de Las Ciencias*, 14(2), 410–426.
https://doi.org/10.25267/rev_eureka_ensen_divulg_cienc.2017.v14.i2.09
- Few, S. (2012). Show Me the Numbers. In *Analytics Press*.
- Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics. In *SAGE Publications*.
- Finley, F. N. (1983). Science processes. *Journal of Research in Science Teaching*, 20(1), 47–54. <https://doi.org/10.1002/tea.3660200105>
- Fogarty, R. (1991). Ten Ways to Integrate Curriculum. *Educational Leadership*, 49(2), 61–65.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1932). *How to Design and Evaluate Research in Education*. Mc Graw-Hill.
- Fraenkel, J., Wallen, N., & Hyun, H. (2018). How to Design and Evaluate Research in Education. In *McGraw-Hill Education*.
- Friel, S. N., Curcio, F. R., & Bright, G. W. (2001). Making Sense of Graphs: Critical Factors Influencing Comprehension and Instructional Implications. *Journal for Research in Mathematics Education*, 32(2), 124–158.
- Garcia, R., & Dacko, S. (2015). DESIGN THINKING FOR SUSTAINABILITY. In *John Wiley & Sons* (pp. 1–431). <https://doi.org/10.1002/9781119154273>
- Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: A guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, 10(2), 486–489. <https://doi.org/10.5812/ijem.3505>
- Ginanjari, J., & Sukoco, I. (2022). Penerapan Design Thinking Pada Sayurbox. *JURISMA: Jurnal Riset Bisnis & Manajemen*, 12(1), 70–83. <https://doi.org/10.34010/jurisma.v12i1.5078>
- Goldman, S., & Kabayadondo, Z. (2016). Taking design thinking to school: How the technology of design can transform teachers, learners, and classrooms. In *Taking Design Thinking to School: How the Technology of Design Can Transform Teachers, Learners, and Classrooms*. <https://doi.org/10.4324/9781317327585>
- Goldman, S., Kabayadondo, Z., Royalty, A., Carroll, M. P., & Roth, B. (2014). Student teams in search of design thinking. *Design Thinking Research*, 1–252. <https://doi.org/10.1007/978-3-319-01303-9>
- Grant, M. M. (2002). Getting a grip on project-based learning: Theory, cases and recommendations. *Meridian*, 5(1).
- Gravetter, F. J., & Wallnau, L. B. (2017). Statistic for the Behavioral Sciences. In *Journal of Chemical Information and Modeling*. <http://www.elsevier.com/locate/scp>

- Greoger, L., Schwitzer, J., Sobel, L., & Malcolm, B. (2019). Design thinking mindset: Developing creative confidence. *Conference Proceedings of the Academy for Design Innovation Management*, 2(1). <https://doi.org/10.33114/adim.2019.09.288>
- Grigorenko, E. L., Jarvin, L., & Sternberg, R. J. (2002). School-based tests of the triarchic theory of intelligence: Three settings, three samples, three syllabi. *Contemporary Educational Psychology*, 27(2), 167–208. <https://doi.org/10.1006/ceps.2001.1087>
- Groth, C. (2017). Making Sense Through Hands: Design and Craft Practice Analysed as Embodied Cognition. In *DOCTORAL DISSERTATIONS* (Vol. 1, Issue 1). <http://dx.doi.org/10.1016/j.cirp.2016.06.001%0A>
- Grotzer, T. A., & Bell Basca, B. (2003). How does grasping the underlying causal structures of ecosystems impact students' understanding? *Journal of Biological Education*, 38(1), 16–29. <https://doi.org/10.1080/00219266.2003.9655891>
- Guilford, J. P. (1956). Psychometric Methods. In *McGraw-Hill*.
- Gürses, A., Çetinkaya, S., Doğar, Ç., & Şahin, E. (2015). Determination of Levels of Use of Basic Process Skills of High School Students. *Procedia - Social and Behavioral Sciences*, 191, 644–650. <https://doi.org/10.1016/j.sbspro.2015.04.243>
- Guzey, S. S., Ring-Whalen, E. A., Harwell, M., & Peralta, Y. (2019). Life STEM: A Case Study of Life Science Learning Through Engineering Design. *International Journal of Science and Mathematics Education*, 17(1), 23–42. <https://doi.org/10.1007/s10763-017-9860-0>
- Han, H. J., & Shim, K. C. (2019). Development of an engineering design process-based teaching and learning model for scientifically gifted students at the Science Education Institute for the Gifted in South Korea. *Asia-Pacific Science Education*, 5(1), 1–18. <https://doi.org/10.1186/s41029-019-0047-6>
- Harlen, W. (1999). Purposes and procedures for assessing science process skills. *International Journal of Phytoremediation*, 21(1), 129–144. <https://doi.org/10.1080/09695949993044>
- Harlen, W. (2014). Helping children's development of inquiry skills. *Inquiry in Primary Science Education (IPSE)*, 1, 5–19.
- Hattie, J. A. C. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. In *Routledge*. <https://doi.org/10.1007/s11159-011-9198-8>
- Hattie, J., & Clarke, S. (2019). Visible Learning : Feedback. In *Routledge*.
- Henriksen, D., Richardson, C., & Mehta, R. (2017). Design thinking: A creative approach to educational problems of practice. *Thinking Skills and Creativity*, 26(March), 140–153. <https://doi.org/10.1016/j.tsc.2017.10.001>
- Holyoak, K. J., & Morrison, R. G. (2005). The Cambridge Handbook of Thinking and Reasoning. In *Cambridge University Press*.
- Honey, M., Pearson, G., & Schweingruber, H. (2014). *STEM integration in K-12 education: status, prospects, and an agenda for research*. National Academies Press.
- Hynes, M., Portsmore, M., Dare, E., Milto, E., & Rogers, C. (2011). Infusing

- Engineering Design into High School STEM Courses. *National Center for Engineering and Technology Education*. <http://ncete.org/flash/pdfs/InfusingEngineeringHynes.pdf>
- Idris, N., Talib, O., & Razali, F. (2022). Strategies in Mastering Science Process Skills in Science Experiments: a Systematic Literature Review. *Jurnal Pendidikan IPA Indonesia*, 11(1), 155–170. <https://doi.org/10.15294/jpii.v11i1.32969>
- Jakubowska, A. (2016). A Student-Constructed Galvanic Cell for the Measurement of Cell Potentials at Different Temperatures. *Journal of Chemical Education*, 93(5), 915–919. <https://doi.org/10.1021/acs.jchemed.5b00124>
- Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students BT - Proceedings of the International Conference on Technology and Vocational Teachers (ICTVT 2017). *Advances in Social Science, Education and Humanities Research*, 102(Ictvt), 251–256. <https://doi.org/10.2991/ictvt-17.2017.43>
- Jin, Y., & Chusilp, P. (2006). Study of mental iteration in different design situations. *Design Studies*, 27(1), 25–55. <https://doi.org/10.1016/j.destud.2005.06.003>
- Johnson, C. C., & Sondergeld, T. A. (2015). Effective stem professional development. In *STEM Road Map: A Framework for Integrated STEM Education*.
- Johnson, D. W., & Johnson, R. T. (2020). Cooperative Learning and Critical Thinking: A Meta-Analysis Study. *Educational Research Review*, 8(1), 13.
- Jolly, A. (2017). *STEM by Design: Strategies and Activities for Grades 4–8*. Routledge.
- Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (1997). *Real-life problem solving: A collaborative approach to interdisciplinary learning*. American Psychological Association.
- Jordan, A., Carlile, O., & Stack, A. (2009). Approaches to learning: A guide for teachers. In *McGraw-Hill, Open University Press*.
- Kamii, C. (1984). Autonomy: The aim of education envisioned by piaget. *The Phi Delta Kappan*, 65(6), 410–415.
- Kampe, J. C. M., & Oppliger, D. E. (2012). On the benefits of using the engineering design process to frame project-based outreach and to recruit secondary students to STEM majors and STEM careers. *ASEE Annual Conference and Exposition, Conference Proceedings*. <https://doi.org/10.18260/1-2--21749>
- Karla, S., & Carla, W. (2023). *Research handbook on design thinking*. Edward Elgar Publishing.
- Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3(1). <https://doi.org/10.1186/s40594-016-0046-z>
- Kemdikbud. (2014). Materi pelatihan guru implementasi kurikulum 2013 tahun ajaran 2014/2015: Mata pelajaran IPA SMP/MTs. In *Kementerian*

Pendidikan dan Kebudayaan.

- Kemendikbudristek. (2024). *Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 032/H/KR/2024* (Issue 021).
- Kertil, M., & Gurel, C. (2016). Mathematical Modeling: A Bridge to STEM Education. *International Journal of Education in Mathematics, Science and Technology*, 4(1), 44. <https://doi.org/10.18404/ijemst.95761>
- Khamhaengpol, A., Sriprom, M., & Chuamchaitrakool, P. (2021). Development of STEAM activity on nanotechnology to determine basic science process skills and engineering design process for high school students. *Thinking Skills and Creativity*, 39(April 2020), 100796. <https://doi.org/10.1016/j.tsc.2021.100796>
- Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267–277. <https://doi.org/10.1177/1365480216659733>
- Koomson, A., Kwaah, C. Y., & Adu-Yeboah, C. (2024). Effect of science process skills and entry grades on academic scores of student teachers. *Journal of Turkish Science Education*, 21(1), 118–133. <https://doi.org/10.36681/tused.2024.007>
- Krajcik, J. S., & Czerniak, C. M. (2018). Teaching Science in Elementary and Middle School. In *Routledge*.
- Krajcik, J. S., & Shin, N. (2014). Project-Based Learning. The Cambridge Handbook of the Learning. *The Cambridge Handbook of the Learning Sciences, Second Edition*, 275–297.
- Lachman, S. J. (1997). Learning is a process: Toward an improved definition of learning. *Journal of Psychology: Interdisciplinary and Applied*, 131(5), 477–480. <https://doi.org/10.1080/00223989709603535>
- Ladachart, L., Cholsin, J., Kwanpet, S., Teerapanpong, R., Dessi, A., Phuangsuwan, L., & Phothong, W. (2022). Ninth-grade students' perceptions on the design-thinking mindset in the context of reverse engineering. *International Journal of Technology and Design Education*, 32(5), 2445–2465. <https://doi.org/10.1007/s10798-021-09701-6>
- Ladachart, L., Khamlarsai, S., & Phothong, W. (2022). Cultivating a Design Thinking Mindset in Educationally Disadvantaged Students Using a Design-based Activity. *International Journal of Innovation in Science and Mathematics Education*, 30(4), 1–14. <https://doi.org/10.30722/IJISME.30.04.001>
- Ladachart, L., Ladachart, L., Phothong, W., & Suaklay, N. (2019). Validation of a design thinking mindset questionnaire with Thai elementary teachers. *Journal of Physics: Conference Series*, 1835(1), 0–7. <https://doi.org/10.1088/1742-6596/1835/1/012088>
- Ladachart, L., Radchanet, V., & Phothong, W. (2022). Design Thinking Mindsets Facilitating Students' Learning of Scientific Concepts in Design-Based Activities. *Journal of Turkish Science Education*, 19(1), 1–16. <https://doi.org/10.36681/tused.2021.106>
- Latifah, N., Hayat, M. S., & Khoiri, N. (2023). Potensi Implementasi Pembelajaran Berdiferensiasi Berorientasi ESD dalam Proyek IPAS Aspek

- Zat dan Perubahannya. *Jurnal Penelitian Pembelajaran Fisika*, 14(2), 261–268. <https://doi.org/10.26877/jp2f.v14i2.16955>
- Lawson, A. E. (2010). *Teaching Inquiry Science in Middle and Secondary Schools*. SAGE Publications. <https://books.google.co.id/books?id=-mbGlHJu4s8C>
- Lee, M. H., Chai, C. S., & Hong, H. Y. (2019). STEM Education in Asia Pacific: Challenges and Development. *Asia-Pacific Education Researcher*, 28(1), 2–5. <https://doi.org/10.1007/s40299-018-0424-z>
- Lemishko, S. S., & Lemishko, A. S. (2017). Cu²⁺/Cu⁺ Redox Battery Utilizing Low-Potential External Heat for Recharge. *Journal of Physical Chemistry C*, 121(6), 3234–3240. <https://doi.org/10.1021/acs.jpcc.6b12317>
- Lemke, J. L. (2001). *Articulating Communities : Sociocultural Perspectives on Science Education*. 38(3), 296–316.
- Lewis, T. (2005). Coming to terms with engineering design as content. *Journal of Technology Education*, 16(2), 37–54. <https://doi.org/10.21061/jte.v16i2.a.3>
- Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2019a). Design and Design Thinking in STEM Education. *Journal for STEM Education Research*, 2(2), 93–104. <https://doi.org/10.1007/s41979-019-00020-z>
- Li, Y., Schoenfeld, A. H., diSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2019b). On Thinking and STEM Education. *Journal for STEM Education Research*, 2(1), 1–13. <https://doi.org/10.1007/s41979-019-00014-x>
- Liedtka, J. (2015). Perspective: Linking Design Thinking with Innovation Outcomes through Cognitive Bias Reduction. *Journal of Product Innovation Management*, 32(6), 925–938. <https://doi.org/10.1111/jpim.12163>
- Lin, K. Y., Wu, Y. T., Hsu, Y. T., & Williams, P. J. (2021). Effects of infusing the engineering design process into STEM project-based learning to develop preservice technology teachers' engineering design thinking. *International Journal of STEM Education*, 8(1), 1–15.
- Liu, X. (2020). Using and developing measurement instruments in science education: A Rasch modeling approach 2nd edition. In *Science and Engineering Education Sources*.
- Long, C. (2012). Teach Your Students to Fail Better with Design Thinking. *Learning & Leading with Technology*, 39(5), 16–20. <http://eric.ed.gov/?id=EJ982832>
- Lor, R. R. (2017). Design Thinking in Education: A Critical Review. In *Asian Conference on Education and Psychology* (Issue May 2017). <https://www.researchgate.net/publication/324684320%0ADesign>
- MacLeod, S., Dodd, J., & Duncan, T. (2015). New museum design cultures: harnessing the potential of design and 'design thinking' in museums. *Museum Management and Curatorship*, 30(4), 314–341. <https://doi.org/10.1080/09647775.2015.1042513>
- Mahmudah, I. R., Makiyah, Y. S., & Sulistyaningsih, D. (2019). Profil Keterampilan Proses Sains (KPS) Siswa SMA di Kota Bandung. *Jurnal Diffraction*, 1(1), 39–43.

- Maier, A. M., & Störrle, H. (2011). What are the characteristics of engineering design processes? *ICED 11 - 18th International Conference on Engineering Design - Impacting Society Through Engineering Design*, 1(August), 188–198.
- Manurung, S. R., & Panggabean, D. D. (2020). Improving students' thinking ability in physics using interactive multimedia based problem solving. *Cakrawala Pendidikan*, 39(2), 460–470. <https://doi.org/10.21831/cp.v39i2.28205>
- Mariam Hoerunnisa, Shinta Purnamasari, & Andinisa Rahmaniar. (2024). Analisis Implementasi Science Technology Engineering Mathematics (STEM) dalam Pembelajaran Ilmu Pengetahuan Alam. *Jurnal Pendidikan Mipa*, 14(1), 79–89. <https://doi.org/10.37630/jpm.v14i1.1469>
- Markula, A., & Aksela, M. (2022). The key characteristics of project-based learning: how teachers implement projects in K-12 science education. *Disciplinary and Interdisciplinary Science Education Research*, 4(2). <https://doi.org/10.1007/s10639-022-11406-9>
- Martin, D. J. (2009). *ELEMENTARY SCIENCE METHODS: A Constructivist Approach Fifth Edition*. Thomson-Wadsworth.
- Marulcu, I., & Barnett, M. (2016). Impact of an engineering design-based curriculum compared to an inquiry-based curriculum on fifth graders' content learning of simple machines. *Research in Science and Technological Education*, 34(1), 85–104. <https://doi.org/10.1080/02635143.2015.1077327>
- McComas, W. F. (2014). The Language of Science Education: An Expanded Glossary of Key Terms and Concepts in Science Teaching and Learning. In *Sense Publishers*. Sense Publishers. https://doi.org/10.1163/9789460910531_009
- Mehalik, M. M., Doppelt, Y., & Schuun, C. D. (2008). Middle-school science through design-based learning versus scripted. Inquiry: Better overall science concept learning and equity gap reduction. *Journal of Engineering Education*, 97(1), 71–85. <https://doi.org/10.1002/j.2168-9830.2008.tb00955.x>
- Melles, G., Howard, Z., & Thompson-Whiteside, S. (2012). Teaching design thinking: Expanding horizons in design education. *Procedia - Social and Behavioral Sciences*, 31(2011), 162–166. <https://doi.org/10.1016/j.sbspro.2011.12.035>
- Melser, D. (2004). The Act of Thinking. In *The MIT Press*. <https://doi.org/10.7551/mitpress/1078.001.0001>
- Mergendoller, J. R., & Thomas, J. W. (2000). Managing project based learning: Principles from the field. *Annual Meeting of the American Educational Research Association*, 1–51. <http://www.bie.org/images/uploads/general/f6d0b4a5d9e37c0e0317acb7942d27b0.pdf>
- Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2007). Learning in adulthood : a comprehensive guide. In *Sustainability (Switzerland)* (Vol. 11, Issue 1). Jossey-Bass.
- Merrill, C., Custer, R. L., Daugherty, J., Westrick, M., & Zeng, Y. (2008).

- Delivering core engineering concepts to secondary level students. *Journal of Technology Education*, 20(1), 48–64. <https://doi.org/10.21061/jte.v20i1.a.4>
- Micheli, P., Wilner, S. J. S., Bhatti, S. H., Mura, M., & Beverland, M. B. (2019). Doing Design Thinking: Conceptual Review, Synthesis, and Research Agenda. *Journal of Product Innovation Management*, 36(2), 124–148. <https://doi.org/10.1111/jpim.12466>
- Milentijevic, I., Ciric, V., & Vojinovic, O. (2008). Version control in project-based learning. *Computers and Education*, 50(4), 1331–1338. <https://doi.org/10.1016/j.compedu.2006.12.010>
- Mills, G. E., & Gay, L. R. (2016). Educational research: competencies for analysis and applications. In *Pearson*.
- Minata, Z. S., Rahayu, S., & Dasna, I. W. (2022). Context-Based Chemistry Learning: A Systematic Literature Review. *Jurnal Pendidikan MIPA*.
- Mohd Hafiz, N. R., & Ayop, S. K. (2019). Engineering Design Process in STEM Education: A Systematic Review. *International Journal of Academic Research in Business and Social Sciences*, 9(5), 618–639. <https://doi.org/10.6007/IJARBS/v9-i5/5998>
- Montgomery, D. C., & Runge, G. C. (2018). Applied statistics and probability for engineers. In *Wiley*.
- Morgan, D. L. (2014). Pragmatism as a Paradigm for Social Research. *Qualitative Inquiry*, 20(8), 1045–1053. <https://doi.org/10.1177/1077800413513733>
- Muntamah, M., Roshayanti, F., & Hayat, M. S. (2023). Potensi Penerapan Pendekatan STEAM (Science, Technology, Engineering, Art, Mathematics) pada Pembelajaran Projek IPAS (Ilmu Pengetahuan Alam dan Sosial) di SMK. *Jurnal Inovasi Pembelajaran Di Sekolah*, 4(1), 77–83. <https://doi.org/10.51874/jips.v4i1.79>
- Munyai, K. (2016). Design Thinking: A Methodology Towards Sustainable Problem Solving in Higher Education in South Africa. *International Association for the Development of the Information Society*, 306–310. <https://eric.ed.gov/?id=ED571612>
- Muttaqiin, A. (2023). Pendekatan STEM (Science, Technology, Engineering, Mathematics) pada Pembelajaran IPA Untuk Melatih Keterampilan Abad 21. *Jurnal Pendidikan Mipa*, 13(1), 34–45. <https://doi.org/10.37630/jpm.v13i1.819>
- Neuman, W. L. (2014). Social Research Methods: Qualitative and Quantitative Approaches. In *Pearson Education Limited*. <https://doi.org/10.2307/3211488>
- NGSS, L. S. (2013). Next Generation Science Standards: For States, By States. In *National Academies Press* (Vols. 1–2). National Academies Press. <https://doi.org/10.17226/18290>
- Nguyen-Thi, H. (2024). Fostering Design Thinking mindset for university students with NPCs in the Metaverse. *Heliyon*, 10(15), e34964. <https://doi.org/10.1016/j.heliyon.2024.e34964>
- Noh, S. C., & Karim, A. M. A. (2021). Design thinking mindset to enhance education 4.0 competitiveness in Malaysia. *International Journal of Evaluation and Research in Education*, 10(2), 494–501. <https://doi.org/10.11591/ijere.v10i2.20988>

- Noorhalida, N., Yuliani, H., & Santiani, S. (2023). Studi Literatur: Pengaruh Project Based Learning Pada Pembelajaran Fisika. *ORBITA: Jurnal Pendidikan Dan Ilmu Fisika*, 9(2), 200. <https://doi.org/10.31764/orbita.v9i2.15688>
- NRC, N. R. C. (2009). Engineering in K-12 education: Understanding the status and improving the prospects. In *The National Academies Press*.
- Nunnally, J., & Bernstein, I. (1978). Psychometric theory (2nd ed.). In *McGraw-Hill*.
- Nurtanto, M., Pardjono, P., Widarto, W., & Ramdani, S. D. (2020). The effect of STEM-EDP in professional learning on automotive engineering competence in vocational high school. *Journal for the Education of Gifted Young Scientists*, 8(2), 633–649. <https://doi.org/10.17478/JEGYS.645047>
- Oliver, K. (2000). Methods for developing constructivist learning on the web. *Educational Technology*, 40, 5–18.
- Olusegun, S. (2015). Constructivism Learning Theory: A Paradigm for Teaching and Learning. *IOSR Journal of Research & Method in Education Ver. I*, 5(6), 2320–7388. <https://doi.org/10.9790/7388-05616670>
- Oogarah-Pratap, B., Bhola, A., & Ramma, Y. (2020). Stage Theory of Cognitive Development—Jean Piaget. In: Akpan, B., Kennedy, T.J. (eds) Science Education in Theory and Practice. In *Springer Texts in Education*. <https://doi.org/10.5748/9contecsi2012/rf-456>
- Ozdem-Yilmaz, Y., & Bilican, K. (2020). Discovery Learning (Jerome Bruner – 1961). In: Akpan, B., Kennedy, T.J. (eds) Science Education in Theory and Practice. *Springer Texts in Education*, 177–190.
- Özgelen, S. (2012). Students' science process skills within a cognitive domain framework. *Eurasia Journal of Mathematics, Science and Technology Education*, 8(4), 283–292. <https://doi.org/10.12973/eurasia.2012.846a>
- Özkul, H., & Özden, M. (2020). Investigation of the Effects of Engineering-Oriented STEM Integration Activities on Scientific Process Skills and STEM Career Interests: A Mixed Methods Study. *Egitim ve Bilim*, 45(204), 41–63. <https://doi.org/10.15390/EB.2020.8870>
- Padilla, M. J. (1990). *The Science Process Skills*. Res. Matters - to Sci. Teach. <https://narst.org/research-matters/science-process-skills>
- Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, 49, 345–375. <https://doi.org/10.1146/annurev.psych.49.1.345>
- Pallant, J. (2016). SPSS Survival Manual. In *Allen & Unwin*.
- Palmer, D. (2005). A motivational view of constructivist informed teaching. *International Journal of Science Education*, 27(15), 1853–1881. <https://doi.org/10.1080/09500690500339654>
- Pande, M., & Bharathi, S. V. (2020). Theoretical foundations of design thinking – A constructivism learning approach to design thinking. *Thinking Skills and Creativity*, 36(October 2019), 100637. <https://doi.org/10.1016/j.tsc.2020.100637>
- Panke, S. (2019). Design Thinking in Education: Perspectives, Opportunities and Challenges. *Open Education Studies*, 1(1), 281–306.

<https://doi.org/10.1515/edu-2019-0022>

- Paparo, M., Dosi, C., & Vignoli, M. (2017). Towards a DT mindset tool evaluation: Factors identification from theory and practice. *Proceedings of the International Conference on Engineering Design, ICED*, 2(DS87-2), 367–376.
- Parkes, M. A., Chen, T., Wu, B., Yufit, V., & Offer, G. J. (2016). “can” You Really Make a Battery out of That? *Journal of Chemical Education*, 93(4), 681–686. <https://doi.org/10.1021/acs.jchemed.5b00496>
- Peck, R., Olsen, C., & Short, T. (2019). Introduction to Statistics and Data Analysis. In *Cengage Learning*.
- Piaget, J. (1964). Part I: Cognitive development in children: Piaget development and learning. *Journal of Research in Science Teaching*, 2(3), 176–186. <https://doi.org/10.1002/tea.3660020306>
- Piaget, J. (1980). The psychogenesis of knowledge and its epistemological significance. In M. Piattelli-Palmarini (Ed.), *Language and Learning: The Debate Between Jean Piaget and Noam Chomsky*. Harvard University Press.
- Pituch, K. A., & Stevens, J. P. (2015). Applied Multivariate Statistics for the Social Sciences: Analyses with SAS and IBM’s SPSS, Sixth Edition. In *Applied Multivariate Statistics for the Social Sciences: Analyses with SAS and IBM’s SPSS, Sixth Edition*. <https://doi.org/10.4324/9781315814919>
- Popham, W. J. (2025). Classroom Assessment: What Teachers Need to Know. In *Pearson*. <https://doi.org/10.1111/j.1745-3984.2002.tb01136.x>
- Pradana, D., Nur, M., & Suprpto, N. (2020). Improving Critical Thinking Skill of Junior High School Students through Science Process Skills Based Learning. *Jurnal Penelitian Pendidikan IPA*, 6(2), 166–172. <https://doi.org/10.29303/jppipa.v6i2.428>
- Primus, D. J., & Sonnenburg, S. (2018). Flow Experience in Design Thinking and Practical Synergies with Lego Serious Play. *Creativity Research Journal*, 30(1), 104–112. <https://doi.org/10.1080/10400419.2018.1411574>
- Purwanti, Sunarno, W., & Ratnasari, N. (2022). Studi Literatur Pembelajaran Project Based Learning Terhadap Keterampilan Berpikir Kreatif IPA SMP. *FORDETAK: Seminar Nasional Pendidikan: Inovasi Pendidikan Di Era Society 5.0*, 148–162.
- Quinn, C. M., Reid, J. W., & Gardner, G. E. (2020). S + T + M = E as a Convergent Model for the Nature of STEM. *Science & Education*.
- Ramma, Y., Bholoa, A., & Watts, M. (2020). Guided Discovery — Robert Gagné. In: Akpan, B., Kennedy, T.J. (eds) *Science Education in Theory and Practice. Springer Texts in Education*.
- Rannikmäe, M., Holbrook, J., & Soobard, R. (2020). Social Constructivism — Jerome Bruner. In: Akpan, B., Kennedy, T.J. (eds) *Science Education in Theory and Practice. Springer Texts in Education*.
- Rauf, R. A. A., Rasul, M. S., Mansor, A. N., Othman, Z., & Lyndon, N. (2013). Inculcation of science process skills in a science classroom. *Asian Social Science*, 9(8), 47–57. <https://doi.org/10.5539/ass.v9n8p47>
- Razali, N. M., & Wah, B. Y. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests. *Journal of*

- Statistical Modeling and Analytics*, 2(January 2011), 21–33.
- Razzouk, R., & Shute, V. (2012). What Is Design Thinking and Why Is It Important? *Review of Educational Research*, 82(3), 330–348. <https://doi.org/10.3102/0034654312457429>
- Reddy, T. B. (2011). *Linden's Handbook of Batteries*, 4th ed. McGraw-Hill, Inc.
- Reimers, J. E., Farmer, C. L., & Klein-Gardner, S. S. (2015). An introduction to the standards for preparation and professional development for teachers of engineering. *Journal of Pre-College Engineering Education Research*, 5(1), 40–60. <https://doi.org/10.7771/2157-9288.1107>
- Reyza, M., Taqwa, A., Ardiansyah, A. A., & Nurhidayat, M. A. (2020). STEM on Science Learning in Indonesia: An Opportunity and A Challenge. *Indonesian Journal of Educational Research and Review*, 3, 160–170.
- Richardson, J. T. E. (2011). Eta squared and partial eta squared as measures of effect size in educational research. *Educational Research Review*, 6(2), 135–147. <https://doi.org/10.1016/j.edurev.2010.12.001>
- Rini, E. F. S., & Aldila, F. T. (2023). Practicum Activity: Analysis of Science Process Skills and Students' Critical Thinking Skills. *Integrated Science Education Journal*, 4(2), 54–61. <https://doi.org/10.37251/isej.v4i2.322>
- Roehrig, G. H., Moore, T. J., Wang, H. H., & Park, M. S. (2021). Is Adding the E Enough? Investigating the Impact of K-12 Engineering Standards on the Implementation of STEM Integration. *Disciplinary and Interdisciplinary Science Education Research*, 3(11), 1–18. <https://doi.org/10.1111/j.1949-8594.2011.00112.x>
- Sakdiah, H., Ginting, F. W., Rejeki, N. S., & Miranda, A. (2022). Pembelajaran STEAM Terhadap Keterampilan Proses Sains Ditinjau dari Sikap Ilmiah Mahasiswa pada Mata Kuliah Kajian Fisika Kejuruan. *Jurnal Penelitian Pendidikan IPA*, 8(5), 2531–2536. <https://doi.org/10.29303/jppipa.v8i5.2313>
- Sanders, M. (2009). STEM, STEM education, STEM mania. *The Technology Teacher*, 68(4), 20–26.
- Sari, A. I. C., & Herawati, M. (2014). Aplikasi Anates Versi 4 Dalam Menganalisis Butir Soal. *Faktor Jurnal Ilmiah Kependidikan*, 1(2), 203–214. <https://core.ac.uk/download/pdf/270252386.pdf>
- Sarker, I. H. (2021). Data Science and Analytics: An Overview from Data-Driven Smart Computing, Decision-Making and Applications Perspective. *SN Computer Science*, 2(5), 1–22. <https://doi.org/10.1007/s42979-021-00765-8>
- Satchwell, R. E., & Loepp, F. L. (2002). Designing and Implementing an Integrated Mathematics, Science, and Technology Curriculum for the Middle School. *Journal of Industrial Teacher Education*, 39(3), 41–66.
- Saul, M. (2024). Piaget's Theory and Stages of Cognitive Development. *Simply Psychology*, August, 1–34. <https://www.simplypsychology.org/wp-content/uploads/simplypsychology.org-Piagets-Theory-and-Stages-of-Cognitive-Development.pdf>
- Scheer, A., Noweski, C., & Meinel, C. (2012). Transforming Constructivist Learning into Action: Design Thinking in education. *Design and Technology Education: An International Journal*.
- Schlott, C. K. (2024). Design Thinking and teamwork-measuring impact: A

- systematic literature review. In *Journal of Organization Design* (Vol. 13, Issue 4). Springer International Publishing. <https://doi.org/10.1007/s41469-024-00177-x>
- Schneider, K. (2024). What Is Learning? *Psychology*, 15(05), 779–799. <https://doi.org/10.4236/psych.2024.155047>
- Schnittka, C. (2012). Engineering Education in the Science Classroom: A Case Study of One Teacher's Disparate Approach with Ability-Tracked Classrooms. *Journal of Pre-College Engineering Education Research*, 2(1), 35–48. <https://doi.org/10.5703/1288284314654>
- Schumacher, T., & Mayer, S. (2018). Preparing Managers for Turbulent Contexts: Teaching the Principles of Design Thinking. *Journal of Management Education*, 42(4), 496–523. <https://doi.org/10.1177/1052562917754235>
- Schweitzer, J., Groeger, L., & Sobel, L. (2016). The Design Thinking Mindset: An Assessment of What We Know and What We See in Practice. *Journal of Design, Business & Society*, 2(1), 71–94. https://doi.org/10.1386/dbs.2.1.71_1
- Scott, D. W. (2009). Sturges' rule. *John Wiley & Sons, Inc, December*, 303–306. <https://doi.org/10.1002/wics.035>
- Scott, P., Asoko, H., & Leach, J. (2007). Student Conceptions and Conceptual Learning in Science. In S. K. Abell & N. G. Lederman (Eds.). *Handbook of Research on Science Education*.
- Sekaran, U., & Bougie, R. (2016). Research methods for business: a skill-building approach. In *John Wiley & Sons*. <https://doi.org/10.1108/lodj-06-2013-0079>
- Selcen Guzey, S., Harwell, M., Moreno, M., Peralta, Y., & Moore, T. J. (2016). The Impact of Design-Based STEM Integration Curricula on Student Achievement in Engineering, Science, and Mathematics. *Journal of Science Education and Technology*, 26(2), 207–222. <https://doi.org/10.1007/s10956-016-9673-x>
- Sexton, S. S. (2020). Meaningful Learning — David P. Ausubel. In: Akpan, B., Kennedy, T.J. (eds) *Science Education in Theory and Practice. Springer Texts in Education*.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). Experimental and Quasi-Experimental Designs for Generalized Causal Inference. In *Houghton Mifflin Company* (Issue 814). https://moodle2.units.it/pluginfile.php/132646/mod_resource/content/1/Estratto_ShadishCookCampbellExperimental2002.pdf
- Shahali, E. H. M., & Halim, L. (2010). Development and validation of a test of integrated science process skills. *Procedia - Social and Behavioral Sciences*, 9, 142–146. <https://doi.org/10.1016/j.sbspro.2010.12.127>
- Silva, F. C., & Sasseron, L. H. (2025). The Positioning of Visual Representations As Epistemic Objects for the Teaching of Organic Chemistry. *Journal of Chemical Education*. <https://doi.org/10.1021/acs.jchemed.4c01018>
- Sitzmann, T., & Ely, K. (2011). A Meta-Analysis of Self-Regulated Learning in Work-Related Training and Educational Attainment: What We Know and Where We Need to Go. *Psychological Bulletin*, 137(3), 421–442.

<https://doi.org/10.1037/a0022777>

- Slavin, R. E. . (2014). *Educational Psychology: A Foundation for Teaching*. In *Pearson Education*.
- Sluijs, F., Uijl, S. G., Vogt, E. T. C., & Weckhuysen, B. M. (2024). Da Vinci Project: Educating Sustainability Change-Makers with Transdisciplinary Challenge-Based Learning and Design Thinking. *Journal of Chemical Education*, 101(10), 4161–4172. <https://doi.org/10.1021/acs.jchemed.4c00158>
- Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2019). Video worked examples to promote elementary students' science process skills: a fruit decomposition inquiry activity. *Journal of Biological Education*, 55(4), 368–379. <https://doi.org/10.1080/00219266.2019.1699149>
- Sonalkar, N., Mabogunje, A., Pai, G., Roth, A. K., & Bernard. (2016). Diagnostics for design thinking teams. *Design Thinking Research*, 1–290. <https://doi.org/10.1007/978-3-319-19641-1>
- Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for Teaching Integrated STEM Education. *Journal of Pre-College Engineering Education Research*, 2(1), 28–34. <https://doi.org/10.5703/1288284314653>
- Stout, P. J., & Klett, M. D. (2020). New Media Technologies and Information Processing Theory—George A. Miller and Others. In: Akpan, B., Kennedy, T.J. (eds) *Science Education in Theory and Practice. Springer Texts in Education*, 115–132. https://doi.org/10.1007/978-3-030-43620-9_9
- Sturges, H. A. (1926). The Choice of a Class Interval. *Journal of the American Statistical Association*, 21(153), 65–66. <https://doi.org/10.1080/01621459.1926.10502161>
- Subandi, Arista, C., Aditya, R., & Masrur, M. F. (2020). Project-Based Learning Model as an Alternative Learning to Build Student's Writing Skill. *Advances in Social Science, Education and Humanities Research*, 491(Ijcah), 722–729. <https://doi.org/10.2991/assehr.k.201201.122>
- Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Penerbit Alfabeta.
- Sulaeman, N. F., Putra, P. D. A., Mineta, I., Hakamada, H., Takahashi, M., Ide, Y., & Kumano, Y. (2021). Exploring Student Engagement in STEM Education through the Engineering Design Process. *Jurnal Penelitian Dan Pembelajaran IPA*, 7(1), 1. <https://doi.org/10.30870/jppi.v7i1.10455>
- Sumintono, B. (2018). *Rasch Model Measurements as Tools in Assesment for Learning*. 173(Icei 2017), 38–42. <https://doi.org/10.2991/icei-17.2018.11>
- Sungur Gul, K., Saylan Kirmizigul, A., Ates, H., & Garzon, J. (2023). Advantages and Challenges of STEM Education in K-12: Systematic Review and Research Synthesis. *International Journal of Research in Education and Science*, 9(2), 283–307. <https://doi.org/10.46328/ijres.3127>
- Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review*, 22(2), 123–138. <https://doi.org/10.1007/s10648-010-9128-5>
- Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive Architecture and Instructional Design: 20 Years Later. *Educational Psychology Review*,

- 31(2), 261–292. <https://doi.org/10.1007/s10648-019-09465-5>
- Tabachnick, B. G., & Fidell, L. S. (2013). Using Multivariate Statistics. In Pearson. <https://doi.org/10.1037/022267>
- Taber, K. S. (2011). Constructivism as educational theory: Contingency in learning, and optimally guided instruction. In J. Hassaskhah (Ed.), educational theory (pp. 39–61). In Nova. <https://doi.org/10.1525/aa.1912.14.2.02a00130>
- Tam, M. (2000). Constructivism, instructional design, and technology: implications for transforming distance learning. *Educational Technology and Society*, April 2000.
- Tam, M. (2015). *Constructivism , Instructional Design , and Technology : Implications for Transforming Distance Learning*. April 2000.
- Taylor, J., & Cox, B. D. (2009). *Journal of the Learning Microgenetic Analysis of Group- Based Solution of Complex Two-Step Mathematical World Problems by Fourth Graders*. December 2014, 37–41. <https://doi.org/10.1207/s15327809jls0602>
- Temiz, B. K. (2020). Assessing Skills of Identifying Variables and Formulating Hypotheses Using Scenario-Based Multiple-Choice Questions. *International Journal of Assessment Tools in Education*, 7(1), 1–17. <https://doi.org/10.21449/ijate.561895>
- Thi-Huyen, N., Xuan-Lam, P., & Thanh Tu, N. T. (2021). The Impact of Design Thinking on Problem Solving and Teamwork Mindset in A Flipped Classroom. *Eurasian Journal of Educational Research*, 2021(96), 30–50. <https://doi.org/10.14689/ejer.2021.96.3>
- Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018). Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education. *European Journal of STEM Education*, 3(1), 1–12. <https://doi.org/10.20897/ejsteme/85525>
- Thomas, J., Condliffe, B., & Quint, J. (2000). Whatever Form a Project Takes , It Must Meet These Criteria To Be Gold Standard Pbl . *Interdisciplinary Journal of Problem-Based Learning*, 22(1), 1–18.
- Thomas, J. W. (2000). A Review Of Research On Project-Based Learning. Autodesk Foundation. <https://doi.org/10.1080/00206814.2019.1702592>
- Thoring, K., & Müller, R. M. (2011). Creating knowledge in design thinking: The relationship of process steps and knowledge types. *IASDR2011: 4th World Conference on Design Research*, May, 1–9.
- Tipmontiane, K., & Williams, P. J. (2021). The Integration of the Engineering Design Process in Biology-related STEM Activity: A Review of Thai Secondary Education. *ASEAN Journal of Science and Engineering Education*, 2(1), 1–10. <https://doi.org/10.17509/ajsee.v2i1.35097>
- Toma, R. B., Yáñez-Pérez, I., & Meneses-Villagrà, J. Á. (2024). Towards a Socio-Constructivist Didactic Model for Integrated STEM Education. *Interchange*, 55(1), 75–91. <https://doi.org/10.1007/s10780-024-09513-2>
- Tufte, E. R. (2001). The Visual Display of Quantitative Information. *Graphics Pr*,

- 177–191. <http://www.amazon.co.uk/dp/0961392142>
- Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st Century Skills through Scientific Literacy and Science Process Skills. *Procedia - Social and Behavioral Sciences*, 59, 110–116. <https://doi.org/10.1016/j.sbspro.2012.09.253>
- Urbina, S. (2004). Essentials of Psychological Testing. In *John Wiley & Sons, Inc.*
- Vaithyanathan, V., & Sivakumar, P. (2013). Effectiveness of cognitive constructivist approach In the acquisition of science process skills. *International Journal of Innovative Research and Development (ISSN 2278–0211)*, 2(1), 56–64.
- Vallis, C. J., Nguyen, H. T., & Norman, A. (2024). Cross-cultural adaptation of educational design patterns at scale. *Journal of Work-Applied Management*, 16(2), 253–268. <https://doi.org/10.1108/JWAM-10-2023-0106>
- Vasquez, J. A., Comer, M., & Gutierrez, J. (2020). *Integrating Into the K – 2 Classroom*.
- Veal, W. R., Taylor, D., & Rogers, A. L. (2009). Using self-reflection to increase science process skills in the general chemistry laboratory. *Journal of Chemical Education*, 86(3), 393–398. <https://doi.org/10.1021/ed086p393>
- Von, E. (1995). A Constructivist Approach to Teaching. In L. P. Steffe & J. Gale. *Constructivism in Education*. <https://doi.org/10.4324/9780203052600-5>
- Von Thienen, J., Meinel, C., & Corazza, G. E. (2017). A Short Theory of Failure. *Electronic Colloquium on Design Thinking Research*. Vol. 17, 17(September), 1–5.
- von Thienen, J., Royalty, A., & Meinel, C. (2016). *Design Thinking in Higher Education*. January, 306–328. <https://doi.org/10.4018/978-1-5225-0643-0.ch014>
- Vygotsky, L. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.
- Vygotsky, L. (1986). Thought and Language. In *The MIT Press*. The MIT Press. <https://doi.org/10.5840/philtoday195711/411>
- Wahono, B., Lin, P. L., & Chang, C. Y. (2020). Evidence of STEM enactment effectiveness in Asian student learning outcomes. *International Journal of STEM Education*, 7(1), 1–18. <https://doi.org/10.1186/s40594-020-00236-1>
- Washburne, J. N. (1936). The definition of learning. *Journal of Educational Psychology*, 27(8), 603–611. <https://doi.org/10.1037/h0060154>
- Watson, A. D. (2015). Design Thinking for Life. *Art Education*, 68(3), 12–18. <https://doi.org/10.1080/00043125.2015.11519317>
- Wertsch, J. V. (1993). Voices of the mind: asociocultural approach to mediated action. In *Harvard University Press*. Harvard University Press.
- Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education*, 75(1), 9–21. <https://doi.org/10.1002/sce.3730750103>
- Wiersma, W. (2000). *Research Methods in Education: An Introduction* (p. 498).
- Winarno, N., Rusdiana, D., Riandi, R., Susilowati, E., & Afifah, R. M. A. (2020). Implementation of integrated science curriculum: A critical review of the literature. *Journal for the Education of Gifted Young Scientists*, 8(2), 795–

817. <https://doi.org/10.17478/jegys.675722>

- Winarno, N., Rusdiana, D., Samsudin, A., Susilowati, E., Ahmad, N. J., & Afifah, R. M. A. (2020). Synthesizing Results from Empirical Research on Engineering Design Process in Science Education: A Systematic Literature Review. *Eurasia Journal of Mathematics, Science and Technology Education*, 16(12), 1–18. <https://doi.org/10.29333/ejmste/9129>
- Wind, S. A., Alemdar, M., Lingle, J. A., Moore, R., & Asilkalkan, A. (2019). Exploring student understanding of the engineering design process using distractor analysis. *International Journal of STEM Education*, 6(1). <https://doi.org/10.1186/s40594-018-0156-x>
- Wismaningati, P., Nuswowati, M., Sulistyaningsih, T., & Eisdiantoro, S. (2019). Analisis Keterampilan Proses Sains Materi Koloid Melalui Pembelajaran Berbasis Proyek Bervisi SETS. *Jurnal Inovasi Pendidikan Kimia*, 13(1), 2287 – 2294.
- Woolfolk, A. (2016). Educational Psychology, Thirteen Edition. In *Pearson Education Ltd.*
- Wrigley, C., & Straker, K. (2017). Design Thinking pedagogy: the Educational Design Ladder. *Innovations in Education and Teaching International*, 54(4), 374–385. <https://doi.org/10.1080/14703297.2015.1108214>
- Yang, X., Zhang, M., Zhao, Y., Wang, Q., & Hong, J.-C. (2022). Relationship between creative thinking and experimental design thinking in science education: Independent or related. *Thinking Skills and Creativity*, 46, 101183. <https://doi.org/https://doi.org/10.1016/j.tsc.2022.101183>
- Yin, R. K. (2018). Case Study Research and Applications: Design and Methods. In *SAGE Publications*.
- Yu, H. (2024). Enhancing creative cognition through project-based learning: An in-depth scholarly exploration. *Heliyon*, 10(6), e27706. <https://doi.org/10.1016/j.heliyon.2024.e27706>
- Zeidan, A. H., & Jayosi, M. R. (2014). Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. *World Journal of Education*, 5(1), 13–24. <https://doi.org/10.5430/wje.v5n1p13>
- Zhou, N., Pereira, N., Chandrasegaran, S., George, T. T., Booth, J., & Ramani, K. (2021). Examining Middle School Students' Engineering Design Processes in a Design Workshop. *Research in Science Education*, 51, 617–646. <https://doi.org/10.1007/s11165-019-09893-x>
- Zubaidah, S. (2018). Mengenal 4C: Learning and Innovation Skills Untuk Menghadapi Era Revolusi Industri 4.0. *Prosiding Seminar Science Education National Conference*, 13(2), 1–10.